THE JPL MICRODEVICES LABORATORY: CAPABILITIES AND ACCESS

Barbara A. Wilson (818) 354-2969
and James L. Lamb (818) 354-5019
Center for Space Microelectronics Technology
Jet Propulsion laboratory
California Institute of Technology
Pasadena, CA 91109

ABSTRACT

The Microdevices Laboratory (MDL) at the Jet Propulsion Laboratory (JPL) is a world-class microdevice and microinstrument research and advanced development center. It houses processing facilities for end-to-end device fabrication based on Si, GaAs, and superconductors down to 0.1 μm feature size. MDL's charter is to develop and demonstrate new microdevice technologies, and to transfer these technologies to NASA users and to industry. In full operation since 1990, MDL has demonstrated rapid prototyping of several new microdevices and technologies.

Ongoing device development work within MDL is sponsored by NASA, SDIO/IST, other government agencies and industry, and executed by an outstanding technical staff. MDL's specialized capabilities and expertise are also available for outside projects, providing these activities do not place JPL in competition with industrial sources. Access can be accommodated for staff from other NASA Centers, other Government Laboratories, and the broader industrial and academic communities

This paper reviews the range and nature of processing capabilities available in the MDL, and procedures for accessing these capabilities.

I. MDL Capabilities and areas of Research

The charter of the Microdevices Laboratory (MDL) at the Jet Propulsion Laboratory (JPL) is to develop and demonstrate microdevice technologies and transfer these technologies to NASA users and to industry. Active programs include electronic and photonic devices, electro-mechanical devices and microinstruments and science sensors. MDL houses. 12,000 square feet of cleanroom environment, from Class 10 to Class 100,000, and 6,000 square feet of diagnostic laboratories. It represents a $30 M investment in facilities and equipment, and receives $1.5 M in annual infrastructure support from JPL. A summary of MDL's device fabrication capabilities is provided in Table I. Sponsored activities span end-to-end design, fabrication and characterization of new device concepts, with a focus on R&D and rapid prototyping. Sponsors include NASA, SDIO, DARPA, Army, Navy and various industrial partners, and the current level of R&D funding is about $10 M per year. Specific research and technology areas include:

- Solid state sensors and microinstruments
- Diode lasers and integrated photonic devices
- Concurrent neural and optical processing hardware
- Nanotechnology and device diagnostics
- High speed devices and THz sources

TABLE I: MDL CAPABILITIES

MATERIAL DEPOSITION Molecular beam epitaxy (MBE) of Si and III-V Metal Organic chemical vapor deposition (MOCVD) Laser ablated deposition of superconductors Plasma enhanced CVD (PECVD) Low pressure CVD (LPCVD) Evaporation, sputtering	SURFACE/INTERFACE CHARACTERIZATION ESCA / SAM TEM SEM STM / BEEM / TTM
LITHOGRAPHY / DEVICE PROCESSING Electron beam and optical lithographies Diffusion and oxidation furnaces Wet etching, reactive ion etching, CAIBE Thermal processing	BULK MATERIALS AND DEVICE CHARACTERIZATION Transport Optoelectronic PL, FTIR, imaging CL

Expertise in these and other device development areas is available among MDL's professional research staff. Specific examples of rapid prototyping successes during recent years include:

- UV CCD incorporating MBE-deposited delta-doping layer
- Real-time path planning chip
- Tunneling IR sensor (micro Golay cell)
- Ultra high frequency capacitive (UHFC) microseismometer
- Gate array on-chip test structures
- Tunneling micro accelerometer/ hydrophore
- Micro weather station (pressure, temperature, wind & humidity sensors)

II. MDL Access

As a Federally Funded R&D Center (FFRDC), JPL strives to provide access to its specialized capabilities, such as those housed in MDL, to both the academic and industrial sectors. Interactions can take the form of formal or informal collaborations, sponsored R&D tasks, direct use of processing facilities, and/or specialized service work. The latter is available only in so far as it does not place MDL in competition with industrial concerns offering similar services. As a non-profit organization, JPL charges R&D and service work at cost. Direct access to the processing facilities by academic or industrial users is also encouraged. All users (internal and external) receive training in the relevant safety practices before beginning work in MDL.

During FY'93, MDL is hosting about a dozen faculty and student and industrial users working within the facility. Current industrial sponsored tasks include the use of electron beam lithography, deposition of semiconductor structures by MBE, development of microsensors for specific proprietary applications, and direct use of the processing facilities for high speed device development. The number of outside users is expected to grow as the facility becomes better known in the community. To inquire about access to MDL equipment or services, potential users should contact the authors.

111. Conclusions

JPL's Microdevices Laboratory is a resource that can be called on to expedite the development of new miniature instruments for a variety of space experiments. Ongoing activities in diode lasers for He magnetometers [Smith et. al.], electron tunneling magnetometers [Kenny et. al.], micromachined Bessel box arrays for charged particle spectroscopy [Staider et. al.], CCDs as particle detectors [Murphy et. al. and Hoenk et. al.], PIN detectors for energetic particle spectroscopy [Mewaldt et. al.], and micromachined x-ray collimators [Hecht et. al.], covered in other articles in this volume may be of particular interest to the space and heliospheric physics communities.

Acknowledgment. The work described in this publication was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

References

Hecht, M. H., F.J. Grunthaner, P.H. Siegel, and T.W. Kenny, Fabrication of Rotating Modulation Collimator Grids by High Aspect Ratio Micromachining (HARMM), in this volume.

Hoenk, M. E., P.J. Grunthaner, F.J. Grunthaner, R.W. Terhune and S. Nikzad, Delta-doped CCDS - A Potential New Low Energy Particle Detector, in this volume.

Kenny, T.W., W.J. Kaiser, H.K. Rockstad, J.K. Reynolds, J.A. Podosek and E.C. Vote, Electron Tunneling Magnetometers, in this volume.

Mewaldt, R. A., W.R. Cook, A.C. Cummings, T.J. Cunningham, M. Mazed and E.R. Fossum, An Interdigitated Pixel PIN Detector for Energetic Particle Spectroscopy in Space, in this volume.

Murphy, G., D. Croley and M. Hoenk, CCDS as Particle Detectors - Possibilities, Problems and Advances, in this volume.

Smith, E. J., R.J. Marquedant, B.A. Wilson and S. Forouhar, The Helium Magnetometer: Potential Reductions in Physical Requirements Without a Loss in Performance, in this volume.

Staider, R. E., T. van Zandt, T.W. Kenny, M.H. Hecht and F.J. Grunthaner, Micromachined Bessel Box Array, in this volume.

Teaming Agreement Between
the National Nanofabrication Facility at Cornell
and JPL's Microdevices Laboratory

This agreement provides a formal linking (constitutes a formal understanding) between the National Nanofabrication Facility (NNF) at Cornell and JPL's Microdevices Laboratory (MDL) at the California Institute of Technology (CIT).

Background

The NNF and MDL have already established a history of successful interactions resulting from a combination of general similarity and specific complementarily of the two organizations. Both faciltieis are involved in (focussed on, etc.) device development and fabrication, with specialized capabilities in fine-line lithography based on electron beam lithography. Both facilities are centrally organized and operated in order to interface effectively with users from outside the parent institution.

However, differences in parent institution and primary sponsorship have led to somewhat different strengths and areas of specialization. The NNF, receiving primary support from the NSF and Cornell University, naturally has a special orientation towards the academic community. Infrastructure support (subsidy from) NSF permits relatively low-cost access for academic users,. This results in an emphasis on fundamental areas of device R&D, and a predominance of faculty and student users, although access for other government-sponsored and ‘industrial users is also encouraged. In-house training for inexperienced users is also a natural part of the NNF charter. MDL, in contrast, is supported as a government facility, and supported primarily by NASA and DoD, places a natural emphasis on more applied device and instrument development (for space applications). MDL is a somewhat larger facility, housing a broader range of suporting materials deposition and characterization equipment, and is operated primarily by a professional staff with a smaller contingent of student users. As an FFRDC, JPL also emphasizes access and assistance to other government, academic and industrial users.

A teaming agreement between the NNF and MDL can take advantage of the complementary strengths of the two facilities, leading to more effective service to the parent organizations, the associated sponsors, and the nanofabrication community in general. Obvious advantages include the ability to utilize equipment at the other facility in cases where different capabilities are present and same equipment in the event of system outage, and Through formal agreement, customers desiring assistance or access to specialized equipment available at the other facility can be directed to the

Value of Teaming Agreement

- Advantage of complementarities
  - More efficient utilization of facilities
    - Select best place to do work
    - Backup facilities in case of system outage
  - Broader& better service to customers
  - Technology/expertise sharing and transfer
  - Leverage of combined sponsor resources

(Other encouragement for teaming.) (As highlighted at a recent workshop sponsored by NSF, DARPA and NRL which brought together a representative group of the micro and nanofabrication communities,)there is a growing need for increased networking and sharing of facilities to avoid unnecessary (and cost-prohibitive) duplication. In the current environment of emphasis on dual use technology development to protect (ensure) future U.S. economic competitiveness, there is also a growning awareness of the value in making these facilities readily available to U.S. industries, especially small businesses entering new technical areas.

(both need to move towards industrial involvement - dual use)

- Complementarity of
  - Facilities & Capabilities
  - Expertise
  - Goals/End Products
  - Customers/Users
  - Sponsors/Infrastructure Support

Structure of Interaction

(the nature of the parent institution and the focus of the primary sponsors)